Analysis of yellowing of a polyvinyl chloride sheet

Part 1: Evolved gas analysis-MS

[Background] The degradation of polymeric materials greatly lowers the material performance and the product's value. Analysis of polymeric materials at every stage in a product's lifetime is essential if it hopes to remain viable in the marketplace. Some changes (color, elasticity, *etc.*) are easily monitored while others require more sophisticated analytical techniques (GC/MS, LC/MS, NMR, *etc.*). This technical note describes the analysis of a polyvinyl chloride (PVC) sheet, one sheet surface is yellow, while the other sheet surface is white. Evolved gas analysis MS (EGA-MS) is used to determine if there are gross chemical differences in the two sides.

[Experimental] The PVC sheet surfaces used are shown in Fig. 1. The analytical system included a Multi-Shot Pyrolyzer (EGA/PY-3030D) which was directly interfaced to the GC injection port. Samples were pulverized and then introduced to the pyrolyzer furnace. EGA thermograms were obtained by increasing the furnace temperature at a constant rate while gasses desorbed from the sample were transferred to the MS detector using a deactivated, heated EGA tube.

[Results] EGA thermograms of the white and yellowed surfaces are shown in Fig. 2. From the average mass spectrum (inset) of the broad peak appearing around 300ºC in both TIC thermograms, the peak can be assigned as hydrogen chloride (HCl). Note that the HCl peak apex from the yellowed PVC surface appears at a lower temperature than that of the white PVC surface. This peak shift is obvious when the extracted ion chromatograms (EIC) using *m/z* = 36 are compared. The rise and apex temperatures for the peak in the white surface sample are 248ºC and 308ºC respectively, whereas they are 160ºC and 300ºC for the yellowed surface. This shows that HCl is desorbed at a lower temperature for the yellowed surface sample, which could be due to a change in the heat-resistance of the yellowed surface. More testing is necessary to fully characterize the yellowed surface – see PYA3-022E. The two EGA thermograms also have a large peak eluting around 450ºC which is attributed to the thermal degradation of the PVC and are essentially identical for both surface samples.

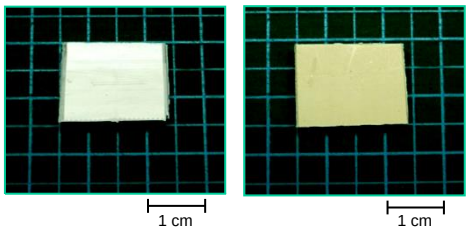

Fig. 1 PVC sheet

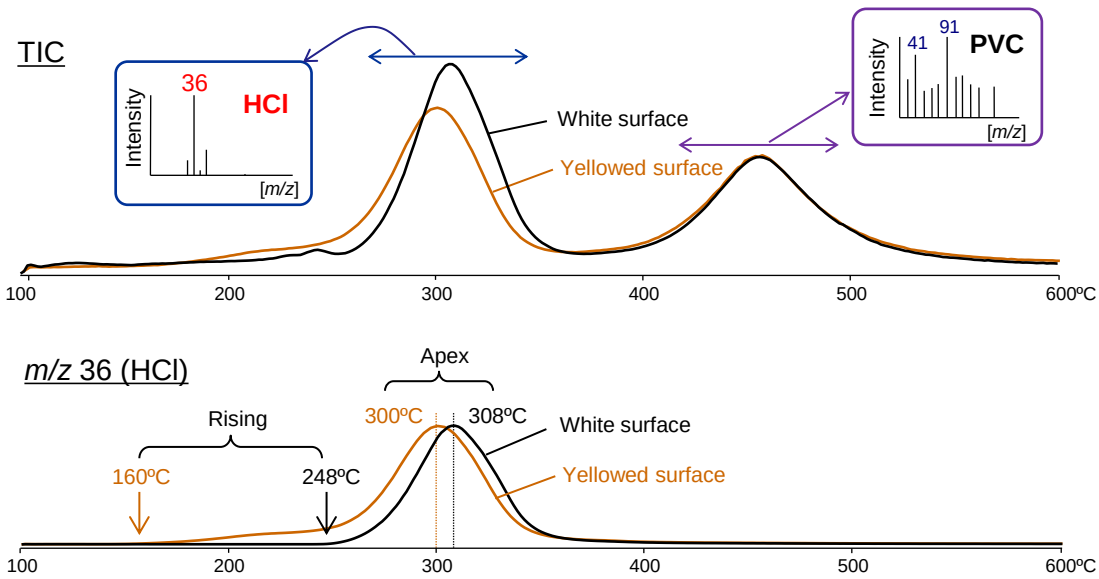

Fig. 2 EGA thermogram of PVC obtained by EGA-MS

Sample wt.: 0.2 mg, furnace temp.: 100 – 600ºC (20 ºC/min), EGA tube: UADTM-2.5N (*L*=2.5 m, i.d.=0.15 mm),
Column flow rate: 1 mL/min, Split ratio: 1/50, GC oven temp.: 300ºC

Keywords : Polyvinyl chloride (PVC), Evolved gas analysis, Yellowing

Product used : Multi-functional pyrolyzer, Auto-Shot Sampler, Eco-Cup LF, Vent-free GC/MS adapter, F-Search, EGA tube

Applications : Polymer analysis, degradation analysis

Related technical notes : PYA3-022E

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